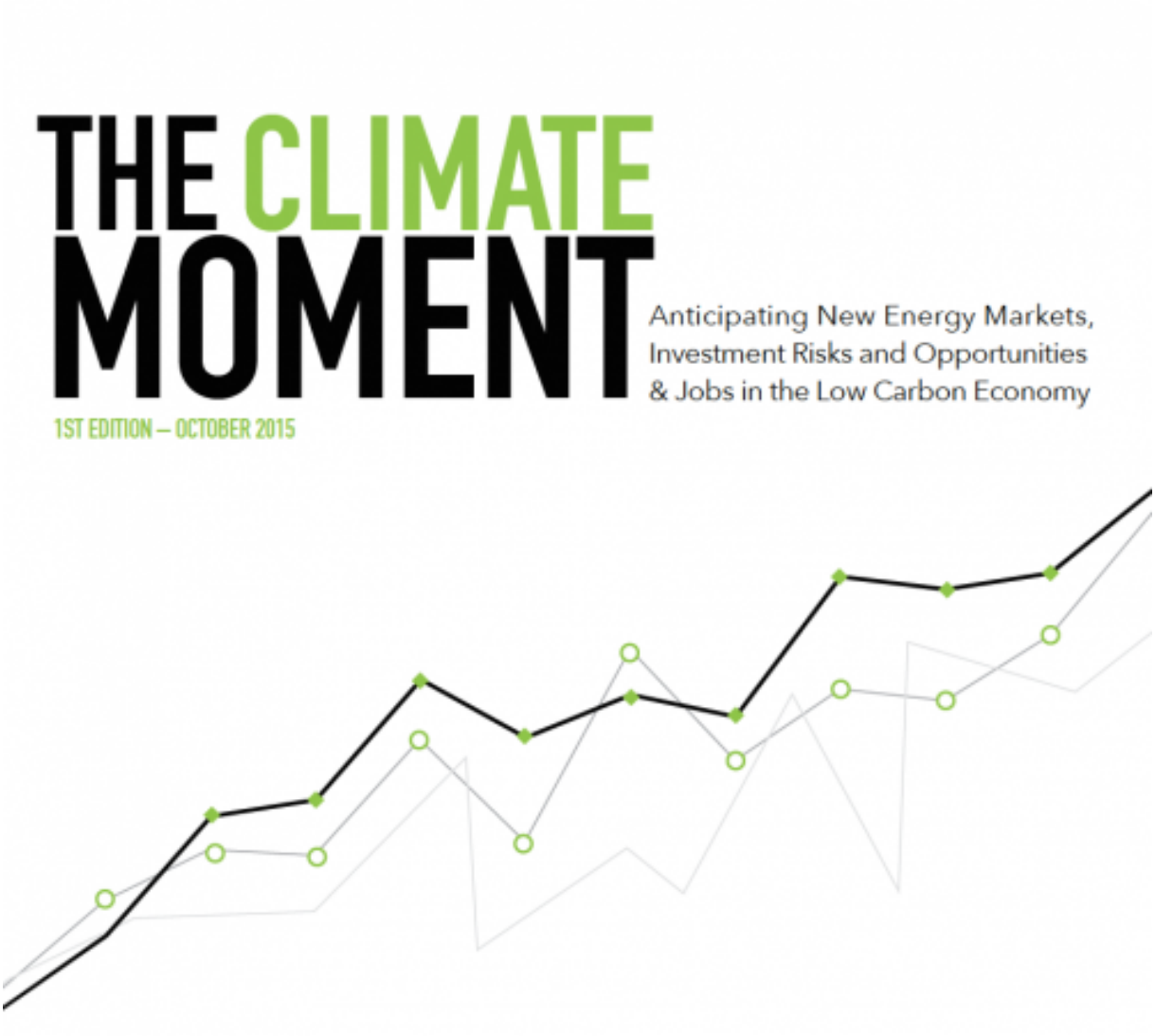

China Country Summary

DUAL CITIZEN KnowlEdge Srl

ABOUT DUAL CITIZEN LLC

Dual Citizen advises clients on how to leverage data analytics and strategic communications to further their growth and development agendas. We work with government ministries, international organizations and private firms on consulting assignments and by sub-contracting with strategic partners. Dual Citizen produces the Global Green Economy Index™ (GGEI), which will publish its 5th edition in the fall of 2016. The GGEI provides a comprehensive ranking of green national reputations and actual performance over 80 countries and 50 cities. For more information, please visit www.dualcitizeninc.com and follow us on Twitter @DualCitizenInc.

ABOUT KNOWLEDGE SRL

KnowlEdge Srl (KE) is a consulting company with international presence, supporting its clients in exploring socio-economic and environmental complexity to inform decision making for sustainability. KE is a leader in developing customized methodologies and tools for the elaboration of integrated strategies, action plans and investment programs, including for green economy and green growth. This includes work in the context of risk assessment, with emphasis on reducing vulnerability and enhancing resilience. Dr. Bassi, the CEO of KE, recently published "Tackling Complexity", a book presenting a step-by-step approach to using systems thinking to solve complex problems in both the socio-political and business environments. For more information, please visit www.ke-srl.com.

The China Climate Moment:

A Systems Approach to Green Investment

Introduction

In the months after the historic climate agreement reached in Paris in December 2015, climate-related investments have been top of mind. Consensus estimates are that around $1 trillion annually will be required to have a chance at keeping global emissions within the 2 degree Celsius budget framework that has structured recent climate negotiations.

Despite the primacy of government goal-setting in reaching the recent climate accord, these investments will have to originate primarily from the private sector. While governments have made a dent in this effort – most notably through a commitment to pledge additional support to help developing countries adapt to the adverse impacts of global climate change – these public efforts will still fall well short of what is required.

Encouragingly, large investors are already evolving to a more multi-dimensional approach to green investments. Environment, social & governance (ESG) criteria have infiltrated investment evaluation in some of the largest banks in the world, including Goldman Sachs and J.P. Morgan. So-called "green bonds" are increasingly popular. Many of the world's largest companies – propelled by pledges at the COP21 in Paris – are making ambitious commitments to renewable energy investments to support power requirements and reduce ecological footprints.

But in facing this enormous task and responsibility, market actors will require new and different analytical approaches to link these global goals with the investments that will help reach them. We believe that an integrated "systems" approach offers a new way to begin to evaluate investments in the context of broader, global goals related to climate change and sustainable development. A traditional evaluation method might assess a green investment opportunity according to the cost of capital, the time period of the project and the cash flow generated over a given period. However, in the context of climate-related investments, a systems approach offers an integrated viewpoint for policymakers, investors and businesses. It can help to unify the demands for returns required by investors with the increasing urgency of allocating capital to projects that further global climate and sustainable development goals.

This brief country summary will explain how and why a systems approach to green investments is valuable in the context of the Chinese economy, in addition to sharing some of the results from our analysis of the economy-wide impacts of China achieving its climate goals.

Systems Analysis and Climate Change

This China country summary is an excerpt from *The Climate Moment: Anticipating New Energy Markets, Investment Risks & Opportunities and Jobs in the Low Carbon Economy*, a study that provides an in-depth analysis of 11 of the largest carbon markets in the world. For each market, we use emission reduction pledges to the Paris Climate Conference (called INDCs in UN-speak)

to calculate the INDC-related investment required, payback periods, avoided costs, energy sector winners and losers and employment impacts. In addition to summarizing these data in a user-friendly presentation, the study includes original research insights revealing tangible policy, investment and business trends in each country for readers to be aware of.

Our modeling forecasts economy-wide outcomes over time with direct links to the stakeholders most impacted by them – policy makers, investors and businesses – so they can utilize a more multi-dimensional set of results to inform their decision making. In the most simple terms, our model takes inputs from each country – including policy interventions and certain assumptions like population trends, GDP growth and energy prices – and generates outputs related to investment required, policy-induced avoided costs and added benefits in areas like employment and performance against secondary targets related to energy consumption and emissions.

The model developed for this study includes several variables across sectors and thematic domains. This can be achieved by ensuring data consistency (within and across sectors), which allows for the creation of a more comprehensive analysis that in our case includes energy demand, supply and emissions, as well as estimations of the investment required to reach desired emission reduction targets, resulting energy savings and employment creation. In practical terms, we have performed "knowledge integration" in a single framework of analysis for low carbon interventions.

Systems Analysis and Green Investment

The results presented in the next sections of this paper are one example of how our model can be applied to assessing linkages between emission reduction pledges and economy-wide impacts in a large market like China. As the results make clear, this integrated viewpoint helps stakeholders understand the relationship between policy interventions (or targets in the case of the INDCs) and the economy-wide impacts: how will the energy sector be transformed? How much investment is required and what is the payback period? What are the avoid costs from these investments? And what are impacts on tangible social variables like employment?

As becomes clear, a systems approach ultimately provides insights on some of the same values that a traditional investment evaluation or one with an ESG overlay may consider. For example, our model considers the payback period of investments in renewable energy or energy efficiency. But in parallel, it offers a projection on the avoided costs to consumers from these investments, as defined by lower energy bills or avoiding social impacts related to pollution. In terms of labor, our model offers projections on the employment impacts of these investments. Will they lead to employment gains or losses and for what type of workers? What is the timing of these impacts?

Given the dynamic nature of energy markets and policy making related to climate change, some will seek simulations for the U.S. with variations on these assumptions. Related to the country-level model for China, we offer the opportunity to change both assumptions (e.g. GDP growth, energy prices) and policies (e.g. target emissions reduction, energy efficiency improvement). Further details on these customized modeling packages can be accessed here. Based on the existing modeling for China, different energy prices and technology costs, as well the projected baseline rate of energy efficiency improvement would be useful to explore in these customized scenarios.

Applying the Model to Market and Investment Decisions

One finding from our work in this space is that in reality, a model like ours must be adaptable to the wide-range of opportunities under consideration by market actors. While central banks, national policy makers and environmental/green economy NGOs are interested in a high-level view of the country-level interdependencies between emissions reduction pledges (INDCs) and these economy-wide impacts, most market actors face a more narrow question: how can this model help to evaluate the worthiness – from a financial and more integrated point of view – of investments under consideration?

There are two main ways in which our model can be adapted in the Chinese market:

- *State-level and regional assessments.* In a large market like China, investments are often made in more local contexts, subjecting decision-makers to vastly different economic and policy realities. For example, states may have more or less ambitious emission reduction targets compared to the national level, and different incentives and policies to support renewable energy and energy efficiency. Our national model for China can be adapted to these more local contexts.
- *Transaction-level assessments.* Many investors are focused on transactions within distinct geographic contexts. While state-level policies and incentives may influence their decision to invest, these investors also require an integrated viewpoint on the ESG impacts of their investment. Our model can also be adapted to supply insight on a transaction-level as well, and incorporate additional third party datasets related to additional ESG variables.

China Climate Commitments

On June 30th, 2015, China submitted its Intended Nationally Determined Contribution (INDC), proposing to cut its emissions per unit of GDP by 60-65% by 2030, as compared to 2005 levels. China's INDC also aims to increase non-fossil fuel sources in primary energy consumption to about 20% by the same date. The INDC also states that China "will work hard" to peak its CO2 emissions before 2030. For the purpose of this analysis, we have modeled two main scenarios: a business-as-usual (BAU) case that assumes the continuation of historic trends and a Low Carbon (LC) scenario that simulates these additional interventions that reduce energy intensity across sectors and increases the use of renewable energy for electricity generation in line with China's INDC.

As the world's top emitter, China's INDC is critical and will have an enormous impact on the global low carbon economy. Given its importance, momentum has been building for months up to this June 30th INDC announcement. In November 2014 at the Asia Pacific Economic Co-operation (APEC) leaders' meeting in Beijing, the U.S. and Chinese presidents made a joint announcement on climate change and clean energy co-operation with President Xi Jinping basically outlining the framework of the INDC formalized in June 2015. The joint announcement marked the first time China has agreed to peak its CO_2 emissions.

Given projected GDP growth and its large population, the dynamics of China's low carbon economy will play a central role in directing investment and business growth between now and the INDC target year. Our analysis takes a deeper look at these dynamics, using model results to project the type of investment required and the associated payback time to renewable energy and

energy efficiency projects needed to reach China's carbon intensity goals. Our model also calculates job creation in these areas and projects how the country's energy mix may evolve between now and 2030. These model outputs are accompanied by research insights showing tangible business opportunities and models for investing in the Chinese market, as well as the main policies for market observers to monitor there.

Assumptions

- GDP growth: 6.29% average annual growth between 2015 and 2018, constant at 6.10% after 2018

2015	2016	2017	2018
6.76%	6.30%	6%	6.10%

Table 1. Assumed GDP growth under all scenarios (IMF, World Economic Outlook, July 2015)

- Population growth: 0.05% annual growth from 2020 to 2040

2020	2025	2030	2035	2040
0.39%	0.17%	0.01%	-0.10%	-0.20%

Table 2. Assumed population growth under all scenarios (UN, World Population Prospects: The 2015 Revision)

- Energy Prices: 2% annual growth rate as of 2014 for coal prices and 4% annual growth rate as of 2014 for petroleum and natural gas prices.
- Energy efficiency improvement: 1.5% from 2000 to 2040 under the BAU scenario; 3% from 2016 until 2040 estimated under the LC scenario, based on INDC target. The improvement would be performed equally across key sectors, including residential, industrial, transport and others.

Selected Takeaways from Modeling of China's National Market

- **While peaking in 2029, China's emissions will be approximately 136% higher than compared to a 2005 baseline.** Despite a strong economic growth rate, China's total energy consumption is projected to peak in 2033 at 102 million TJ/year under the Low Carbon scenario. Similarly, CO_2 emissions will peak in 2029 at 11.9 billion tCO_2e. On the other hand, per capita emissions increase from 3.9 ton/person/year in 2005 to 8.3 in 2030 and 7.2 ton/person/year in 2040. This is a notable increase yet smaller than most other developed countries.
- **The Chinese market will demand significant technology transfer to realize energy efficiency improvements.** The average total investment for energy efficiency reaches, as a share of GDP, 0.84% in the period 2015-2030. This level of investment is very ambitious. To realize it, existing technologies will need to be distributed throughout the country more fully and technology transfer from developed countries will need to deepen significantly.
- **If Chinese solar manufacturers focus sales in the domestic market, far less renewable energy investment is required in the LC scenario.** China has plenty of capacity in renewable energy to meet RE targets without expanding production of renewable assets.

This is because most of its production is being exported. If manufacturers redirect this production for sale in the domestic Chinese market, the vast majority of the investment simulated in the LC scenario would not be required.

- **Renewable energy and energy efficiency investments have very different payback periods.** Our modeling suggests that the INDC-related investment is fully repaid (when considering policy-induced avoided costs) within 13 years in the Low Carbon scenario. This includes a faster payback for energy efficiency (4 years) and a longer one for renewable energy, assuming that the Chinese renewable energy sector continues to focus primarily on export markets.
- **Under the Low Carbon scenario, hydropower generation increases at the same pace as other renewable energy generation.** The share of non-hydro renewables generation (e.g. solar, wind and biomass) of total electricity generation amounts to 18% in 2015 and 19% in 2030. On the other hand, the share of hydropower generation of total electricity generation amounts to 13% in 2015 and 16% in 2030. The total use of renewable energy for power generation therefore reaches 35% in 2030, against 20% in the BAU case and 26% today.

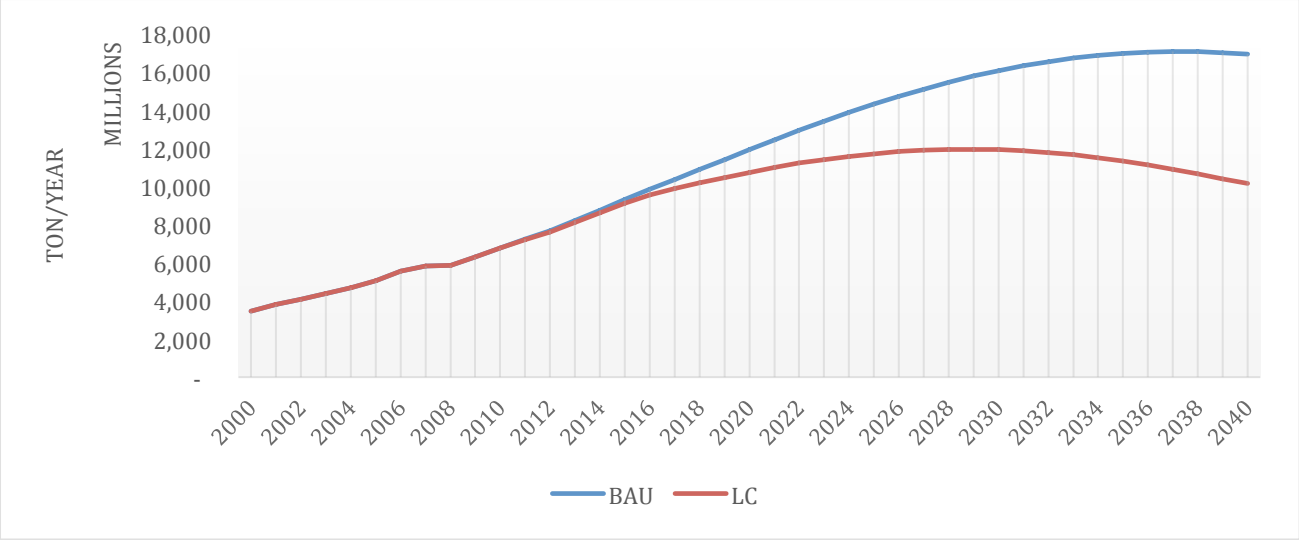

Figure 1: Total CO_2 emissions under the BAU and LC scenarios.

Selected Research Insights

The following research insights are highlighted to provide readers with a more nuanced view of dynamics driving the development of China's low carbon economy and opportunities within it. These insights can touch upon policies, investment dynamics, business opportunities and talent or human capital. These insights in the Chinese market include: (1) Green Bonds, (2) Power Sector Reforms, (3) State-Owned Enterprise Reform, (4) Human Capital and Green Talent.

Green Bonds

Green bonds are an increasingly popular way to raise capital to finance environmentally friendly or 'climate aligned' projects. Globally, the bond market is worth over $100 trillion, while bonds officially designated as 'green' represent only a fraction of this at approximately $66 billion in 2015. Yet estimates suggest that the total value of unlabeled but 'climate aligned' bond market is

far larger, in the order of $530 billion, with a large proportion of these coming from Chinese projects[1].

The first issuance of green bonds in China began in July 2015, with Goldwind Science & Technology raising $300 million to fund a wind project in the Xinjiang Region. The project was over-subscribed by nearly a factor of five, suggesting that demand for such products will be high. In terms of 'climate aligned' projects, the numbers are even greater with large projects in the Chinese transport sector driving much of the volume. China Railway Corp. accounts for approximately $25 billion alone. The Climate Bonds Initiative estimates as much as 99% of bonds issued in the transport sector meet their definition of 'climate aligned' while remaining unlabeled as 'green'. China is expected to issue up to $5 billion in green bonds by the end of 2015.

The Green Finance Committee previously discussed is exploring how to better incentivize investments in green bonds. Some tools being considered include: exclude the loans funded by green bond issuance from loan-deposit ratios for commercial banks; 75% preferential risk weighting and capital regulation requirements for financial institutions for green bonds; preferential risk treatments in capital-risk ratios for banks investing in green bonds, allowing a 50% downward adjustment on the risk asset for green bonds[2].

Power Sector Reforms

In March 2015 China's government released a draft of power sector reform plans. The paper - *Deepening Reform of the Power Sector (Chinese language)*[3] – broadly defined a possible approach to reform in the national power sector. The reforms are intended to help China meet its growing power requirements, while simultaneously reaching ambitious goals around reducing emissions, promoting renewables and boosting energy efficiency.

A number of policy issues are identified in the document as key areas that need to be addressed in order for China to meet its energy goals. In particular, the need for grid company reform, increased direct access and retail competition, demand side management, and improvements in renewables integration and distributed generation were highlighted. The document also mentions that market mechanisms will be increasingly used to promote competition and diversification in the sector[4].

Reform in China's power sector could tangibly impact green markets there. Decoupling grid company revenues from electricity sales growth would remove a barrier to realizing greater energy efficiency across the economy. Improving the timing of when power plants are turned on and off (power sector dispatch) could reduce power plant emissions. And encouraging the actual purchase and use of all of the solar and wind energy China has already set up to produce, a high government priority[5]. The final reform blueprint for China's power sector should provide additional signals and details on how companies and investors can take advantage.

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[1] The Climate Bonds Initiative is the leading source on green bond data including monthly volumes of issuance, project lists and other reporting and knowledge. For more information about the initiative please visit: https://www.climatebonds.net.

[2] For more background, please see "Establishing China's Green Financial System: Final Report of the Green Finance Tax Force" https://www.cbd.int/financial/privatesector/china-Green%20Task%20Force%20Report.pdf

[3] The full report (Chinese only) can be accessed here: http://www.ne21.com/news/show-64828.html

[4] http://www.raponline.org/featured-work/a-new-framework-for-chinas-power-sector

[5] Hove, Anders, "Three Must-Reads on Carbon Reduction and China's Environment," http://www.paulsoninstitute.org/paulson-blog/2015/03/27/required-reading-three-must-reads-on-carbon-reduction-and-chinas-environment-2/ March 27, 2015

State-Owned Enterprise (SOE) Reform

In September 2015, China's central government released a long-awaited blueprint for state-owned enterprise (SOE) reform. This is likely to result in the opening up of SOEs to the private sector, in a move towards a mixed ownership model. Yet realizing this model of mixed ownership is no simple task. Entrenched SOE leadership who have benefited from years of preferential loans and protection from competition will resist giving up these privileges. And markets may not embrace greater investment in SOEs, assuming that in order to extend these privileges to SOE leadership, the parts opening up to private investment will likely be less attractive pieces of the enterprise[6].

Many SOEs are clustered in sectors of strategic importance, including banking, energy, mining, public utilities and transport, and it is unlikely that governments will to want to give up control in such key sectors. There is concern around the extent to which private investors will have management control over corporatized SOEs. Furthermore, many of the factors prompting the reforms in the first place - high debt, low profitability and inefficiency – will continue to deter investors.

SOE reform will interact with China's climate economy in both a positive and negative direction. In one sense, greater transparency and focus on efficiency could force carbon-intensive SOEs into greater environmental responsibility. At the same time, however, the government may continue to shelter SOEs in the traditional energy sector from broader market shocks, introducing an unfair advantage compared to newer renewable energy companies. In July 2015, government-backed buying propped up Petro China Company Limited (the biggest component of the Shanghai Composite Index) amidst an otherwise brutal slide in Chinese markets[7].

Human Capital and Green Talent

While China's future demand for renewable energy and increased energy efficiency is indisputable, the extent to which its economy and educational system can create the necessary workers to fuel these new areas remains unclear. A high-level look at China's market for talent paints a mixed picture. On the one hand, China appears to be "in balance" at educating the right quantity of Science, Technology, Engineering and Mathematics (STEM) graduates to match the demand for labor projected from the market[8]. On the other hand, certain sectors central to China's new climate economy complain that China's workers currently lack the necessary skills and training.

Along with internal challenges with the Chinese labor market, China struggles with attracting and retaining trained talent from around the word. Chinese students educated abroad stay in their host countries at a rate of over 80% and China continues to lack a comprehensive national skill development strategy. Shortages of qualified electricians and wind energy workers are anticipated in the coming years as Chinese universities rarely offer specialized training linked to renewable energy.

The lack of a formal skill development strategy had led to a rise in various government-supported initiatives. Of note is the Green Campus Program through which the China Green Building Council promotes the concept of green building and organizes training and knowledge exchanges on 18 university campuses throughout the country. There has also been support from the Ministry

[6]Financial Times, "China's State-Owned Enterprise Reforms Face Compromise" http://www.ft.com/intl/cms/s/0/5eeeb84a-5aaa-11e5-97e9-7f0bf5e7177b.html#axzz3lio59sZO September 2015

[7] Curran, Enda, "China's State-Owned Companies May Face Reform," http://www.bloomberg.com/news/articles/2015-07-31/china-s-state-owned-companies-may-face-reform July 30, 2015

[8] Oxford Economics, "Global Talent 2021: "How the new geography of talent will transform human resource strategies," https://www.oxfordeconomics.com/media/default/thought%20leadership/global-talent-2021.pdf. 2012

of Human Resources and Social Security through their Start and Improve your Own Business (SIYB) initiative, which has developed a green dimension designed to support emerging sectors in an environmentally conscious manner. With our modeling projecting rapid expansion of labor needs in renewable energy in the next five years, market observers should monitor developments around green talent and training there.

Working Together

There are a few ways to leverage our existing modeling and expertise in this area, for policy makers, investors and other market actors. We already have completed two product offerings that can be accessed through our website:

- The first is the full study of the 11 largest carbon emitters, providing model outputs and research insights for each market. The study can be purchased directly online for $499 or by contacting us directly at the emails below.
- The second is the customization option discussed earlier, allowing clients to modify assumptions in our study and receive the resulting simulations. This customization option can be requested directly online for $2,999 or by contacting us directly.
- The third is to engage with us to structure a tailored consulting arrangement to apply our existing modeling framework to support decision makers.

For more information, please contact Dr. Andrea Bassi (andrea.bassi@ke-srl.com) or Jeremy Tamanini (jeremy@dualcitizeninc.com).

Summary Data Table

The table below provides readers with a sample of the outputs from our national systems model for the Chinese market:

Time (Year)	2015	2020	2025	2030	2040
CO2 EMISSIONS					
Total CO2 emissions (million ton/year)					
LC	9,121	10,739	11,712	11,920	10,140
BAU	9,304	11,921	14,302	16,064	16,922
CO2 reduction relative to 2005 (%)					
LC	81%	113%	132%	136%	101%
BAU	84%	136%	183%	218%	235%
Emissions per capita (ton/person)					
LC	6.64	7.65	8.23	8.34	7.16
BAU	6.77	8.49	10.05	11.23	11.95
Emissions intensity (kg/US$)					
LC	1.48	1.24	1.00	0.78	0.43
BAU	1.51	1.38	1.22	1.04	0.72
ENERGY DEMAND					
Total country energy demand (TJ/year)					
LC vs BAU	0%	-6%	-12%	-18%	-29%
Energy demand per capita (TJ/person)					
LC	0.06	0.06	0.07	0.07	0.07
BAU	0.06	0.07	0.08	0.09	0.10
Energy demand per unit of GDP (TJ/US$)					
LC	12,643	10,367	10,367	6,622	4,108
BAU	12,643	11,021	9,501	8,106	5,798
ELECTRICITY GENERATION					
Share of RE electricity generation (%)					
LC	30%	30%	31%	34%	46%
BAU	26%	23%	21%	20%	22%
INVESTMENT AND SAVINGS					
Total cumulative investment (billion US$)					
LC vs BAU	138	799	1,689	2,944	6,834
Total annual investment RE+EE (billion US$/year)					
LC vs BAU	138	141	205	284	491
Total avoided costs cumulative (billion US$)					
LC vs BAU	1.16	272	1,352	3,659	13,614
Total avoided costs annual (billion US$/year)					
LC vs BAU	1.16	104	304	579	1,368
EMPLOPYMENT					
Energy efficiency employment fuels (person)					
LC vs BAU	-985	666,363	1,619,096	2,676,588	4,770,551
Energy efficiency employment electricity (person)					
LC vs BAU	80	252,270	636,927	1,047,537	1,749,858
Electricity supply employment (person)					
LC vs BAU	469,784	-515,236	-825,538	-863,657	-194,656